DEHYDROXYLATION OF GLYCEROL TO PROPYLENE GLYCOL OVER COPPER/ZINC OXIDE-BASED CATALYSTS: EFFECTS OF CATALYST PREPARATION AND REGENERATION

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A Thesis Submitted in Partial Fulfilment of the Requirements
for the Degree of Master of Science
The Petroleum and Petrochemical College, Chulalongkorn University
in Academic Partnership with
The University of Michigan, The University of Oklahoma,
Case Western Reserve University, and Institute Français du Pétrole
2010

530018

Thesis Title:	Dehydroxylation of Glycerol to Propylene Glycol over Copper/Zinc Oxide-based Catalysts: Effects of Catalyst Preparation and Regeneration
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บทคัดย่อ

สุชาติ ปั้นหยัด : การผลิตโพรพิลีนไกลคอลจากกลีเซอรอลโดยตัวเร่งปฏิกิริยาที่มีทองแดงและสังกะสีออกไซด์เป็นส่วนประกอบพื้นฐาน: ผลกระทบของวิธีเตรียมตัวเร่งปฏิกิริยาและการนำกลับมาใช้ใหม่ (Dehydroxylation of Glycerol to Propylene Glycol over Copper/Zinc Oxide-based Catalysts: Effects of Catalyst Preparation and Regeneration) อาจารย์ที่ปรึกษา: ผศ.ดร. ศิริพร จงผาติวุฒิ รศ.ดร. ธีรศักดิ์ ฤกษ์สมบูรณ์ ผศ.ดร. ธรรมนูญ ศรีทะวงศ์ ศ.ดร. สมชาย โอสุวรรณ 80 หน้า

กลีเซอรอลเป็นผลิตภัณฑ์พลอยได้หลักจากการผลิตไบโอดีเซลด้วยกระบวนการทรานเอสเตอริฟิเคชัน (Tranesterification) การเพิ่มขึ้นของการผลิตไบโอดีเซลส่งผลให้ปริมาณกลีเซอรอลล้นตลาด ดังนั้นการนำกลีเซอรอลไปเปลี่ยนเป็นสารเคมีที่มีมูลค่าสูงขึ้นเช่น โพรพิลีนไกลคอล โดยผ่านปฏิกิริยาดีไฮดรอกซิเลชันโดยใช้ตัวเร่งปฏิกิริยาก็ถือเป็นทางเลือกหนึ่งที่น่าสนใจ งานวิจัยนี้ได้ศึกษาประสิทธิภาพของตัวเร่งปฏิกิริยาทองแดงและสังกะสีออกไซด์บนอะลูมินา ($Cu\text{-}ZnO/Al_2O_3$) ในการทำปฏิกิริยาดีไฮดรอกซิเลชันโดยเตรียมตัวเร่งปฏิกิริยาด้วยเทคนิคที่แตกต่างกัน คือ วิธีเอิบชุ่ม (IWI) วิธีการตกตะกอนร่วม (COP) และวิธีโซล-เจล (SG) ตัวเร่งปฏิกิริยาที่เตรียมขึ้นทั้งหมดถูกนำไปทดสอบประสิทธิภาพของการทำปฏิกิริยาในเครื่องปฏิกรณ์แบบต่อเนื่องชนิดเบดนิ่งที่อุณหภูมิ 250 องศาเซลเซียส ภายใต้ความดันของไฮโดรเจนที่ 500 ปอนด์ต่อตารางนิ้วเกจ ตัวเร่งปฏิกิริยาเหล่านี้ยังได้ถูกนำไปวิเคราะห์ด้วยเทคนิคต่างๆ เช่น SAA XRF XRD TPR และ TPO จากการศึกษาพบว่า ตัวเร่งปฏิกิริยาที่เตรียมโดยวิธีเอิบชุ่มมีประสิทธิภาพและความเสถียรที่สูงที่สุดซึ่งอาจเกิดเนื่องมาจากปริมาณการเกิดถ่านโค้กที่ต่ำ รวมถึงโลหะบนพื้นผิวของตัวเร่งปฏิกิริยามีความเสถียรสูง นอกจากนี้ยังพบว่าการเสื่อมสภาพของตัวเร่งปฏิกิริยามีสาเหตุมาจากการทับถมของถ่านโค้กและการรวมตัวกันของโลหะกัมมันต์ ดังนั้น ประสิทธิภาพของตัวเร่งปฏิกิริยาจึงไม่สามารถทำให้ฟื้นคืนด้วยปฏิกิริยาออกซิเดชันของถ่านโค้ก

ABSTRACT

5171023063: Petrochemical Technology
Suchart Panyad: Dehydroxylation of Glycerol to Propylene Glycol over Copper/Zinc Oxide-based Catalysts: Effects of Catalyst Preparation and Regeneration
Thesis Advisors: Asst. Prof. Siriporn Jongpatiwut, Assoc. Prof. Thirasak Rirksomboon, Asst. Prof. Thammanoon Sreethawong, Prof. Somchai Osuwan 80 pp.
Keywords: Dehydroxylation/ Glycerol/1,2-Propanediol/Propylene Glycerol/ Cu-ZnO/Al_2O_3/IWI/Co-precipitation/Sol-gel/Regeneration

Glycerol is a major by-product from vegetable oil transesterification to biodiesel. The increase in biodiesel production results in the marketed surplus of glycerol. The catalytic dehydroxylation of glycerol to propylene glycol is one of the most attractive routes to convert glycerol to high value-added products. In this work, the dehydroxylation of glycerol to propylene glycol was investigated over Cu-ZnO/Al_2O_3 catalysts prepared by different techniques—i.e. incipient wetness impregnation (IWI), co-precipitation (COP), and sol-gel (SG) methods. The prepared catalysts were tested for their catalytic activity in a packed-bed reactor at 250 °C and 500 psig under hydrogen atmosphere. Fresh and spent catalysts were characterized by several techniques including SAA, XRF, XRD, TPR, and TPO. Among the catalysts tested, the impregnated Cu-ZnO/Al_2O_3 catalyst provided the highest catalytic performance which could be due to its low coke formation and high stability of metal on surfaces. Furthermore, causes of the catalyst deactivation were found to be the combination of deposited carbon and sintering of active metals. Therefore, the catalytic activity of the Cu-ZnO/Al_2O_3 catalysts cannot be recovered by a simple method for coke removal.

ACKNOWLEDGEMENTS

This work would not have been possible without the assistance of the following individuals.

First of all, I greatly appreciate Asst. Prof. Siriporn Jongpatiwut, Assoc. Prof. Thirasak Rirksomboon, Asst. Prof. Thammanoon Sreethawong, Prof. Somchai Osuwan, my thesis advisors, for providing invaluable recommendations, creative comments, and kindly support throughout the course of this research work.

I would like to thank Asst. Prof. Boonyarach Kitiyanan and Dr. Veerapat Tantayakom for their kind advice and for being my thesis committee.

I am grateful for the partial scholarship and partial funding of the thesis work provided by the Petroleum and Petrochemical College, and by the National Center of Excellence for Petroleum, Petrochemicals, and Advanced Materials, Thailand.

Special appreciation goes to all of the Petroleum and Petrochemical College's staff who gave help in various aspects, especially the Research Affairs staff who kindly help with the analytical instruments used in this work.

For my friends at PPC, I would like to give special thanks for their friendly support, encouragement, cheerfulness, and assistance. Without them, two years in the College would have been meaningless for me. I had the most enjoyable time working with all of them.

Finally, I am deeply indebted to my parents and my family for their unconditionally support, love, and understanding.

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